INTEGRATED LOGISTICS SUPPORT (ILS) OVERVIEW; by Chuck Sproull 7/97

29. The ILS Plan, as its name implies, is the management document that provides the basis for an INTEGRATED LOGISTICS SUPPORT Program. It lists and describes all the ILS elements of a new system or piece of equipment, describes the relationships between each of the elements, tells who is responsible for making decisions about each element, how each element influences the design of the prime equipment, what support resources and technical data are required to provide support to the users, a funding summary that shows how much each element will cost per year, and a schedule of design and acquisition of support resources that correlates with the prime equipment production and deployment schedule. It is best for support resources to be in place when the equipment is delivered.

INTEGRATED LOGISTICS SUPPORT PLAN (ILSP) PURPOSE

1. Fulfill requirements of:
   DoDD 5000.39, OPNAVINST 5000.49A, NAVSEAINST 5000.39,
   Specific Operational Requirement #__________, and [SYSCOM]TASK __________.
2. Define logistic support elements for the equipment.
3. Define management objectives for a program relating to all ILS Elements.
4. Address specific supportability considerations necessary for effective, economic and timely support of prime and associated equipment during its full life cycle from Engineering Development through expenditure/disposal.
5. Identify:
   a. support elements already in place; compared with total support required and logistics support elements still required; and
   b. logistic-related issues requiring resolution,
   c. personnel having specialties, responsibilities and authority appropriate for resolving logistics support issues, making decisions and funding/tasking/contracting for the acquisition of required support elements.
6. Display ILS Management Team (ILSMT) including names and specialties of Logistic Element Managers (LEM) and other management and technical personnel.
7. Establish necessary actions and responsibilities to resolve supportability issues and in planning, designing, acquiring and providing required support in a timely, cost effective way.

30. Here is a typical ILS Plan Outline. Related programs are conducted by engineers and specialists in other functional areas.

INTEGRATED LOGISTICS SUPPORT PLAN (ILSP) 30

ILS MANAGEMENT
   (Funding, Schedule, System Description)
   (Decisions: Who, When)
DESIGN INTERFACE
   S&TE, Operator, Platform
MAINTENANCE PLANNING
   PM, CM, O/I/D-Level
SUPPLY SUPPORT (Spares, Expendibles)
SUPPORT AND TEST EQUIPMENT(S&TE)
   (ILSP) ***(ILSP)***
PACK, HANDLE, STORE, TRANSPORT
   Equipment, Spares...
TECHNICAL DATA (TD)
   PTD (Spares)
   Procedures (Handle, Store, Operate,
   Maintain, Test, & S/W Documentation)

31. Following is a short description of some logistics software analysis tools and related programs:

Logistics Support Analysis (LSA) (more recently called "Supportability Analysis") is an important part of systems engineering. It is a structured way of asking the right questions to gather the data required for designing supportable systems and planning for support resources. The LSA Record (LSAR), a large data base structured by indenture level (system, cabinet, assembly, subassembly, and piece parts, components and attaching hardware). LSAR can consist of over 500 data elements, including data used to identify each part and information related to all the ILS elements. There is more information about this later.

FACILITIES
Training, Storage, Test, Maint & Repair
MANPOWER & PERSONNEL
Supply, Operators, Test, Maintenance
TRAINING & TRAINING EQUIPMENT - ***(ILSP)***
Test, Handling, Storage, Operation, Maintenance
RELATED PROGRAMS:
Analysis Programs:
LSA, RBS, LCC, LORA, FMECA, RCM, FRACAS
Configuration Management
Quality Assurance
Quality Evaluation (Stockpile)
Engineering Technical Services
Guaranties, Warranties
Value Engineering, ECPs
Recording and Reporting (Feed Back)
Safety, Human Factors
Disposal, Reutilization
ILSP - FOR MANAGERS TO PLAN FOR INTEGRATED LOGISTICS SUPPORT
OLSS - FOR USERS TO OBTAIN REQUIRED SUPPORT RESOURCES

Life Cycle Cost analysis (LCC) adds up all the costs of a program (over 100 cost elements) that occur throughout the life cycle, from development, through production, use, maintenance and disposal.

Level of Repair Analysis (LORA) helps determine the best maintenance level for removal, replacement and repair of an item (Organizational, Intermediate or Depot) based partly on cost and availability of test equipment, cost and quantity of spare parts, and types of trained personnel at each location. It examines what is the most cost-effective way to repair a system, for example, (1) remove and replace failed items at organizational level by user/technicians and then repair items by original manufacturer; or (2) send failed equipment to intermediate level for removal, replacement and repair or disposal of failed assemblies).

Readiness Based Sparing (RBS) is a disciplined integration of design engineering, logistics support, maintenance and configuration management. RBS compares cost of readiness (in terms of operational availability - Ao) compared with cost of spares. An Ao of .95 may require a spares budget of $10.000 and achieving an Ao of .99 may cost $20,000. The issue is this, "Is higher availability worth the extra money?".

Failure Mode Effects and Criticality Analysis (FMECA) examines all the possible kinds of failures that can occur in a piece of mechanical or electronic equipment, follows cause-and-effect relationships for each failure, including other failures that can happen as a result of the initial failure and examines how critical these failures are relative to the intended use of the equipment. One failed part may cause another to fail. For instance, a short circuit in a capacitor can cause transistors and computer chips to be exposed to a power surge that may burn them out.

Reliability Centered Maintenance (RCM), started by the airline industry in the 1960s, attempts to increase reliability of systems by increasing preventative maintenance tasks (PM) to find potential failures before they happen. RCM compares the cost of PM versus the cost of no PM (which includes more expensive corrective maintenance (CM)). Using inputs from FMECA, RCM analysis first examines whether mechanical and electrical equipment failures are immediately evident or hidden to the operators, and whether failures cause safety, operational and costly problems or other failures. Results of RCM analysis include installing indicators (warning lights, gages, meters ... etc) to detect potential failures and reliability degradation before failures occur, installing redundant or fail-safe circuits and bypass valves ... etc to eliminate or postpone safety and operational consequences of failures, and developing PM tasks to inspect and service equipment frequently enough to prevent or significantly reduce failures. This is like checking car engine oil level with a dip-stick every 500 miles (1/2 minute), adding a quart of oil when needed ($1, 1 minute), and changing oil and filter ($12, 30 minutes)) every 3,000 miles to prevent the safety, operational and economic consequences of blowing up a $500 engine every 10,000 miles and spending an additional $500 for corrective maintenance (repair); (compare the average cost per 10,000 miles of $48 and 2 hours versus $1,000 and 20 hours). RCM is a new version of an old proverb; "An ounce of PM is worth a pound of CM" or in this case, 20 quarts of PM is worth more than 1/2 ton of CM.

Failure Reporting and Corrective Action System (FRACAS) is an important feed-back loop that develops a historical data base of assembly and part failures and of repairs to a piece of equipment.

Configuration Management (CM) is an important program that defines the indenture structure of a system, as in LSA, and controls the drawings and technical documentation related to that system throughout its development and service life. When the design of a system is well defined, a baseline configuration is established. Any engineering changes to that design (such as new part numbers or indenture structure) can then be formally tracked and accounted for. This can be critically-important in maintenance planning where more than one version of the system is manufactured and delivered to various users.

32. For example, suppose 1000 special purpose, O-Level repairable radios, having unit cost of $300 each, will be built for a special project and used on aircraft, ships and land vehicles. The total procurement cost is $300,000. The Operation and Maintenance Manual is written complete with repair procedures, parts lists and drawings of all repairable assemblies, and sent to all the intended users. And Spare Parts Provisioning list is sent to the supply system to buy the required spare parts and stock them at user locations in anticipation of future repair requirements. These both contain part numbers for that original radio design.

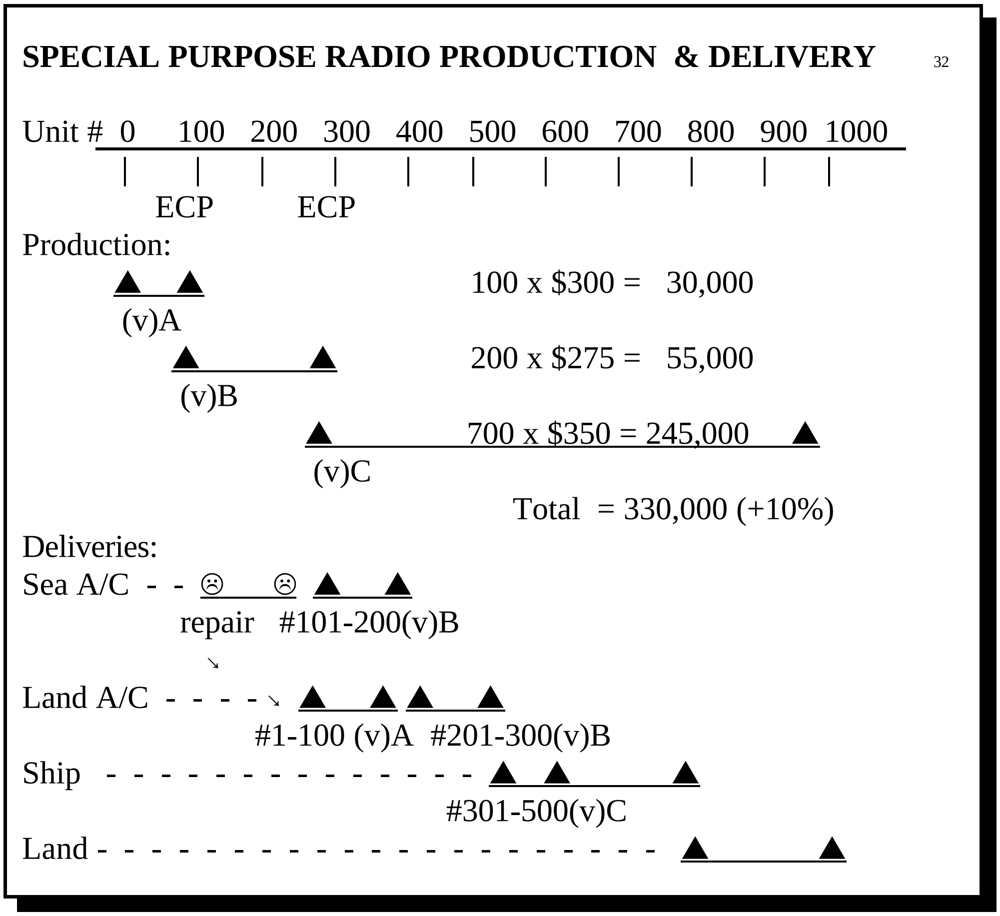
After production begins (say at unit 100), the manufacturer discovers a less expensive way to produce the amplifier assembly of the radio, having the same function as the other model, but using fewer and cheaper parts and with a modified wiring diagram. This new configuration is $275 per unit. He submits an Engineering Change Proposal (ECP) to the Program Manager for approval. The manufacturer will begin making the new version at S/N 101 at $275 per unit.

By the time unit # 300 is built, the first 100 units were delivered to an aircraft squadron deployed on an aircraft carrier. Soon they discover that the extreme shock of catapult take-offs and tail-hook landings caused excessive failures, so the Program Manager's engineering staff redesigns the radio circuitry to be more rugged, using a new combination of parts with new part numbers, and with a unit cost of $350, and they submit an ECP. This ECP is approved and production of the third version begins at unit S/N 301.

What is the new total cost? [$300 x 100] + [$275 x 200] + [$350 x 700] = $330,000, or about 10% more than originally budgeted. The failures are repaired and the whole lot of 100 radios is reinstalled aboard land-based aircraft where the landings are more gentle.

After production and delivery, there are three configurations in the field, but only one Operation and Maintenance manual at all the user locations, and one spare parts list and one set of spares in the supply system.

Suppose after a year of operation, the amplifier in radio S/N 350 (shipboard version) fails during a critical part of the mission at a remote location at sea, and needs to be fixed in one hour. This is a version 3 radio.



The O-Level technician will try to use the version 1 Maintenance manual procedures to locate the failure to the amplifier, but will be surprised and confused when he tries to use the older wiring diagram to locate the individual component that failed in the newer version amplifier. If he does manage to locate the failed part, and tries to find its part number in the parts list so he can obtain a replacement, he will discover the old parts list doesn't contain the part he needs or that it has a different value.

After he does some extra, time consuming research and finds the right part number for that component, he will be frustrated when he goes to the supply bin only to discover the required part is not in stock; because the provisioning list used to provide parts to that location was for version 1, not for version 3. So now the mission is a failure and they need to wait until the ship is back in port to repair the radio.

This is an example of Configuration mis-management. An effective Configuration Management program would have generated a revision to the drawings, and change pages or revisions to the maintenance manual and provisioning list, for each version of the radio, indexed by serial number and distributed to the user locations where that version of the radio was sent. This is also another case of disintegrated logistics support, like the one discussed above. Remember, integrated logistics is planning ahead for the full life cycle support of an item.

<u>Quality Assurance</u> is also planning ahead for user satisfaction, but is concerned with what happens during the manufacturing process. This will be described later in more detail.

<u>Quality Evaluation</u> includes periodic inspection or lot sample testing to determine the quality of expendable items that have been in storage for long periods of time, like ordnance (bombs, bullets, missiles, sonobuoys).

<u>Engineering Technical Services</u> include the special arrangements for technical personnel from the equipment manufacturer to assist operations and maintenance of that equipment.

<u>Guaranties and Warranties</u> are contractually binding statements that give customers and users and customer the hope (expectation, assurance of quality and support) satisfaction ahead of time, before they operate and maintain the equipment. <u>Value Engineering</u> attempts to keep improving the manufacturing process to make better products at lower cost. This involves the process mentioned above, called <u>Engineering Change Proposals</u> (ECPs). These may be Class I or small changes such as part number substitution or corrections to drawings, or Class II changes which affect the <u>form, fit, or function</u> of a

product. Whether and ECP is generated to reduce unit cost of an item or improve its performance, it is very important for engineers and logisticians to examine the impact of that change on each of the 10 ILS elements. Because the product and its support elements are so closely integrated together, any change to the equipment design will affect its technical documentation and one or more elements. As will be shown later in this briefing, an ECP that promises to save money on production costs, even a small change, may ripple through the ILS elements like falling dominoes and cause an unacceptable increase in the distribution, operations, and maintenance costs.

Recording and Reporting Feedback is from the user back to the beginning of the manufacturing process. This is like an extension of the quality control testing and defect return feedback loops on production lines. Both are for the purpose of reducing defects and failures, and increasing equipment reliability, supportability and user satisfaction. This is the time when the effectiveness of customer support and satisfaction can start to be measured.

Safety and Human Factors, related through the Design Interface element, seeks to make operation and maintenance of tasks as safe, easy and convenient as possible. This is a big factor in user satisfaction.

Disposal and Reutilization was described above as the final ILS element. In planning for all of these elements, there are opportunities to be conservative in the use of money, natural resources and chemicals such as cleaners, paints, lubricants, and to cause minimum negative impact to our environment.

An Operational Logistics Support Summary (OLSS) is structured like an ILSP and considers the same elements, but is written to assist users in obtaining the support they need to operate and maintain the equipment. It contains lists of available support resources and points of contact for each ILS element.

33. **QUALITY**. The most important factor that determines the success of a business is customer satisfaction. Many business are started by the sponsor or owner's own financial arrangements. But the businesses that continue and prosper are the ones that develop a consistent group of satisfied customers who will continue to finance that business. A customer is satisfied when the product (or service) fulfills all of his/her user requirements for operation, performance, reliability, appearance, ...etc. The overall concept of customer satisfaction is referred to as Quality. The effort that plans for and assures customer satisfaction has two phases.

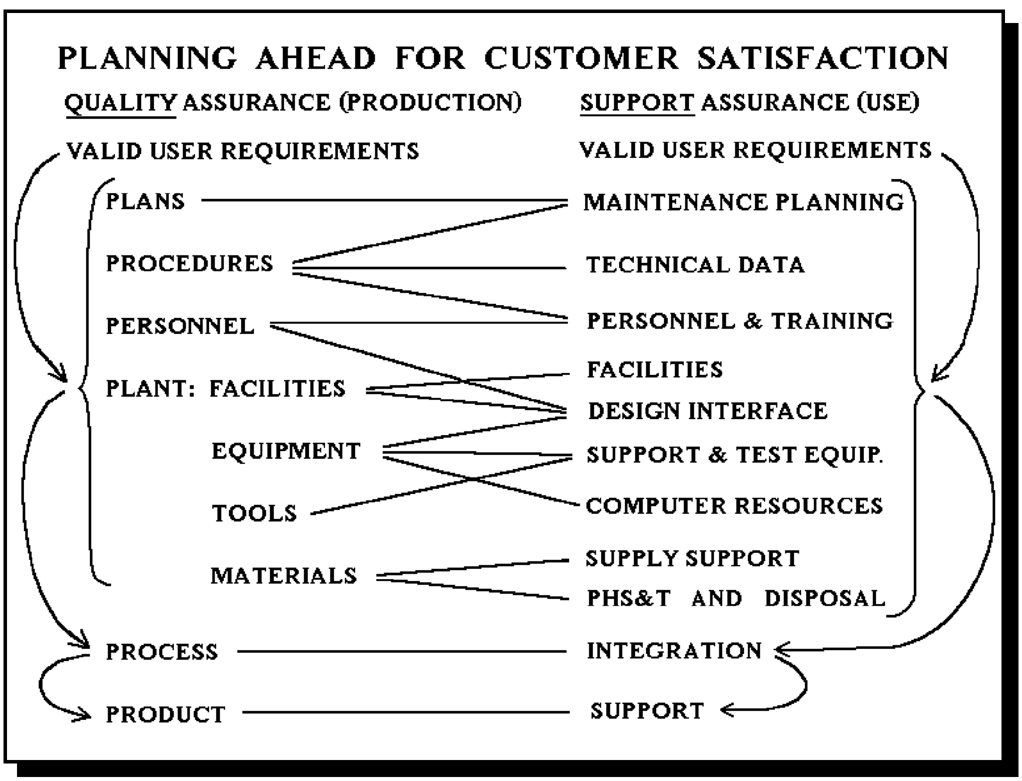
First, QUALITY ASSURANCE helps design and build customer satisfaction into products during the production process. But, planning for customer satisfaction needs to begin long before production. Why do we need quality assurance? Products were first made for users by skilled craftsmen and artisans who had a wholesome pride about their work and a feeling of direct accountability to their customers and to the users of their products. So they learned all about their customer's requirements and designed quality or potential customer satisfaction into their products. If people who bought or used their products were not satisfied, no one would buy their products and the business owners would not be able to make a decent living.

During the mass production era, factory workers were separated from the feeling of direct accountability to the customer, so they lost some of that professional self-esteem. This resulted in lower quality products and lower customer satisfaction. Manufacturing corporations attempted to solve this problem by Quality Control, or by inspecting and testing quality of products at various places along an assembly line. But all this did was uncover low quality after it was designed and manufactured into products. This resulted in costly waste, rework programs, time delays, customer dissatisfaction and loss of business.

Quality Control consisted of setting up test and inspection stations along an assembly line to occasionally check the quality of the product up to that point. But managers found that if the workers did not feel accountable to the end user of their product, if they didn't know where they were in a large process, if all they did was punch in and out on the time clock and do average quality work, and they let the QC people find the defects and return them for rework or disposal, this physical feedback added a lot of extra cost to the manufacturers operations. In other words, QC can't inspect or test quality into a product, it must be designed and built in.

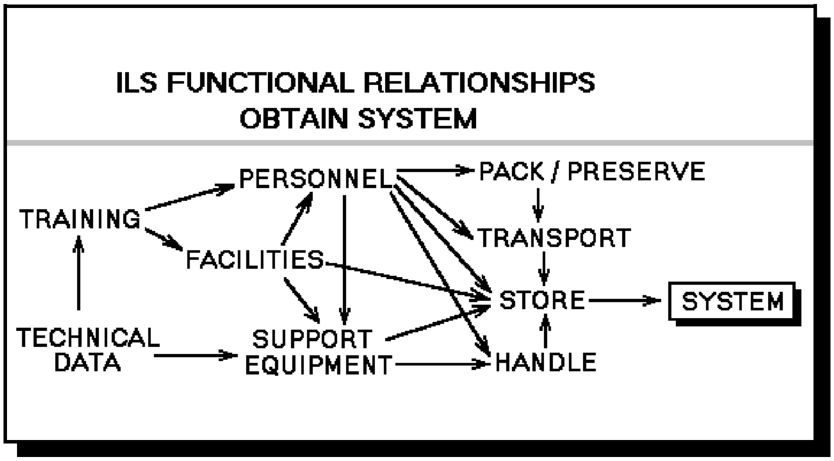
Quality Assurance (also called Product Assurance) attempted to solve this problem by showing members of an assembly line what their customers needed, where each worker fit into the big picture and how they each could inspect their own work and add quality to their portion of the product. QA attempted to train, certify, encourage and inspire the workers to be like artisans for their part of an assembly process. Total Quality Management (TQM) or Leadership (TQL) is the effort to make entire corporations, from upper management to laborers, accountable to customer requirements for the quality of their products.

A quality program always begins with valid customer requirements. Suppose a customer needs a new product to accomplish something no other product can do. The design engineer would start designing an item that would hopefully satisfy that customer. At the same time, plans are made to set up a new assembly line or expand an existing one, or develop a whole new business. Procedures are developed to implement the plans and set up the new line/business, describing the business operations and how the parts will "flow" together. A plant is established consisting of facilities, manufacturing equipment, manufacturing and maintenance tools, and materials such as raw materials, components, and subassemblies made by other vendors and suppliers. This is an aspect of Business Logistics discussed earlier. All of these elements are certified as being appropriate for satisfaction of the customer, therefore "valid" requirements. Personnel are hired, trained and certified to perform the special processes necessary for manufacturing and testing. Then there is a walk through of the new assembly process to certify that the whole combination of elements will satisfy customer requirements. Finally, the products are manufactured and sold to all those waiting customers.



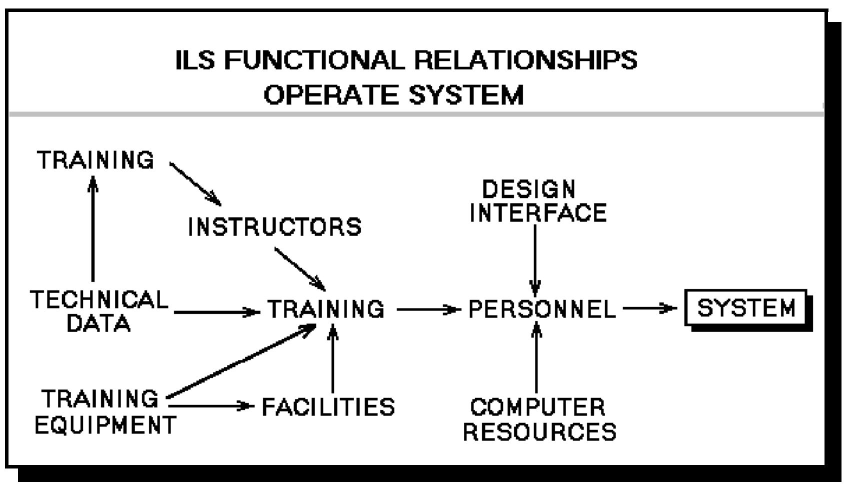
34. The second phase of customer satisfaction occurs during distribution, use and

maintenance. This is when ILS resources and services are supplied to the customer along with the product. But similar to quality, planning for customer satisfaction through customer and product support must also begin during the design process, long before production and use. This Vu-Graph shows how the 10 Quality elements correspond to the 11 ILS elements. Since certifying all elements of a manufacturing process is called quality assurance, we may think of ILS planning as support and readiness assurance. This is what warranties and guarantees do for customers and users of products.

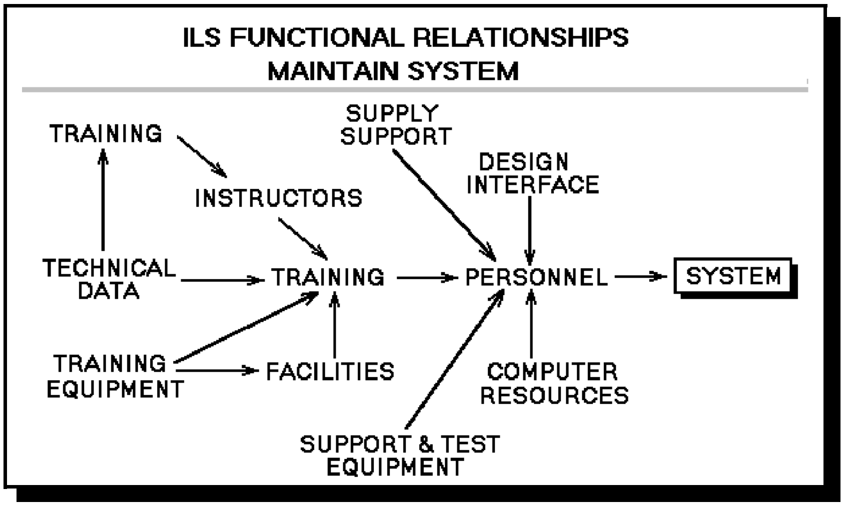


35. Earlier we saw that during the system design and development process, ILS elements should be integrated by a concurrent, parallel, coordinated communication effort. Here are some diagrams that show the importance of integrating ILS elements during distribution, operation and maintenance phases. The relationships between ILS elements now have series interdependence or cause and effect relationships that depend on how well they were integrated during planning. Now, if one of those ILS elements is missing, it delays the rest of that part of the support process.

For example, suppose a heavy piece of new sophisticated automotive production machinery is to be delivered to a car factory. If weight handling equipment (crane) at the user's facility is either not there or not working (that is, not ready for use), it would be impossible to unload, receive, store and use that machine. If it requires some special storage accommodations like environmental control, until its installation area is ready (strengthened foundation), or if certain technical data is missing the equipment custodian may not know to store that machine properly, possibly exposing it to potential damage or reliability degradation.



36. If the machine is delivered and installed, but the operator training facility is not ready, then operator personnel are not ready to use it and is the machine is not ready for operation. If the training facility is ready but the technical information for the instructors is not delivered, the training facility can not be used and the operators can not be trained.



37. This next example is similar to the one from Vu Graph 25. Say the machine is installed and being operated effectively, but six months out of warranty the power control assembly fails and a special piece of test equipment needed to isolate that failure has still not been delivered. Maybe the test equipment vendor went bankrupt or test equipment is delivered but no one knows how to operate it. So now the auto assembly line experiences a costly delay until a technician from the original equipment manufacturer can repair the failure and order a new assembly. One can spend hours elaborating on cause and effect impacts to business and military operations due to lack of <u>integrated</u> logistics support <u>planning</u> before production and lack of coordination afterwards, during distribution, operation and maintenance. So it is easy to see the critical importance of Integrated Logistics planning and support early in the development process.